NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

The Development of an Information System Master Plan for the Pacific Missile Range Facility, Barking Sands, Hawaii

by

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March 1992

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL *(If applicable)* 32	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000	7b. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS Program Element No. / Project No / Task No. / Work Unit Accession Number

11. TITLE *(Include Security Classification)*
THE DEVELOPMENT OF AN INFORMATION SYSTEM MASTER PLAN FOR THE PACIFIC MISSILE RANGE FACILITY, BARKING SANDS, HAWAII

12. PERSONAL AUTHOR(S) Rolando A. Apollo and Paul D. Bennett

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(year, month, day)*	15. PAGE COUNT
Master's Thesis	From To	1992 March 26	77

16. SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17. COSATI CODES			18. SUBJECT TERMS *(continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUBGROUP	Information Systems

19. ABSTRACT *(continue on reverse if necessary and identify by block number)*

This thesis provides a general description of the communication facilities and systems currently used by the Pacific Missile Range Facility (PMRF). The system interface requirements to support current range operations are identified and a description of current communications system shortfalls is provided along with recommendations for short-term improvements. A vision of the future is also provided. It suggets that PMRF adopt a coordinated, integrated, and centralized approach to range communications. Current and future communications system technologies such as digital communications, applicability of different transmission media, and application of the Integrated Services Digital Network (ISDN) are mentioned as avenues for implementing a fully integrated data, voice, and video real-time information network that will support future PMRF users' requirements.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS REPORT ☐ DTIC USERS	Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE *(Include Area code)*	22c. OFFICE SYMBOL
Dan C. Boger	(408) 646 2056	AS/BO

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

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of the requirements for the degree of

MASTER OF SCIENCE IN TELECOMMUNICATIONS SYSTEMS MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This thesis provides a general description of the communication facilities and systems currently used by the Pacific Missile Range Facility (PMRF). The system interface requirements to support current range operations are identified and a description of current communications system shortfalls is provided along with recommendations for short-term improvements.

A vision of the future is also provided. It suggests that PMRF must adopt a coordinated, integrated, and centralized approach to range communications. Current and future communications system technologies such as digital communications, applicability of different transmission media, and application of the Integrated Services Digital Network (ISDN) are mentioned as avenues for implementing a fully integrated data, voice, and video real-time information network that will support future PMRF range users' service requirements.

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I. INTRODUCTION

As we approach the year 2000, technological trends are transforming communications networks into more ubiquitous and intelligent systems. There is less tolerance for error; even a small mistake, a failure to respond fast enough, or a misunderstanding may have awesome consequences. Today's communications systems are strategic weapons, and the ability to obtain desired levels of performance and efficiency are directly linked to the effective use and management of those systems. In order to remain viable in the future, organizations must take advantage of new technologies and emerging services. [Ref. 1:p. 7]

Increasingly, technology has enabled communications/computer systems to share and provide information from high-level organizations to the lowest level unit commanders. The need to exchange information between dissimilar communications and computer systems is great, and the commanders need to obtain information from these systems is an essential element to effective mission control. From electronic mail, to logistical support, to sensitive and classified information, these systems must interface effectively to meet the stated objectives. The benefits of technological improvements--lower operational costs, lower maintenance, and greatly increased capability--justify the need to invest in advanced systems that incorporate the latest technology.

A. BACKGROUND

The Pacific Missile Range Facility (PMRF), Barking Sands, Hawaii, was established in 1958 as a mid-Pacific detachment of the Pacific Missile Test Center (PMTC), Point Mugu, California, for the express purpose of supporting the REGULUS missile program in the Hawaiian area. With the advent of ballistic missile and satellite programs and the introduction of more advanced weapons into the Fleet, the range was expanded to fulfill the requirement for a large area, multi-threat range in which a carrier battle group could conduct open ocean, free-play exercises in a realistic environment [Ref. 2:p. I-1-1]. The large open ocean environment surrounding the PMRF provides the capability to easily realize all existing and future Fleet training requirements. An integral element in fulfilling these requirements, as well as other aspects of PMRF's mission, are the communications systems employed. Communication is the life blood of the range. Timely and accurate communications are fundamental and essential for the coordination and transmission of data during operations and for the administrative and logistical support of operational participants. Therefore, the communication systems used must be both reliable and efficient to operate.

Yet, in spite of what must be accomplished on the range, the development of communications systems has not been able to keep pace with present demands, let alone prepare for the future demands upon the system.

The systems presently installed at PMRF and its associated satellite communication sites are approaching the end of their Integrated Logistics Support (ILS) life cycle and are becoming increasingly expensive to maintain and operate. Although the current communications systems remain mission capable, improvements to these systems have lacked a long range plan and documentation. The competition for development dollars has delayed some important communication installations and improvements. In fact, prior to February 1991, most of the system engineering was accomplished off-site by PMTC, Point Mugu, California, which unilaterally determined which systems were best for PMRF. As a result, systems were developed without a clear understanding of PMRF requirements and as a result, were incapable of performing at peak efficiency/effectiveness because of a lack of understanding of the influence of local conditions on communications.

B. PURPOSE

The primary purpose of this thesis is to provide PMRF management with a master plan for the development of an integrated/centralized information system. The objectives of this plan are:

- to consolidate communication services into limited sites and systems in order to reduce costs
- to improve system efficiency and effectiveness by providing remote control of all communications equipment at satellite sites distant from Barking Sands
- to increase communication security
- to provide for more flexible communications systems, and
- to increase the overall capacity of the communication system and provide room for expansion

C. SCOPE

A systems design methodology provides the basic framework for this research. This methodology emphasizes the whole system instead of individual components and strives to optimize system effectiveness instead *of the improvement of* component systems. Furthermore, the system design methodology provides an external view of the system and enables the planner to influence future trends by becoming a leader in the process. [Ref. 3:p. 62]

This thesis will not provide a complete understanding of the technical aspects of implementing a communication system. For that purpose, additional material is needed to provide more detailed engineering specifications. However, pertinent design factors such as the degree of distribution, centralization options, and organizational issues will be discussed.

D. THESIS ORGANIZATION

The thesis is divided into six subsequent chapters: Mission and Operations of PMRF, Current Communication System and Facilities, Current Communications System Shortfalls and Problems, Short Term Communications Plan, Future Vision and Ten Year Plan, and finally Conclusions.

Chapter II, Mission and Operations of PMRF, will provide an overview of the basic mission and typical operations that are supported by the PMRF. A brief overview of the communication systems and their interface requirements with other locations outside of PMRF will be offered.

Chapter III, Current Communication Systems and Facilities, details the configuration of the current communications systems that support the operational and administrative functions of PMRF and its associated satellite instrumentation sites. The equipment that is installed at the various sites and the purpose of this equipment is discussed. The facilities that are vital for the integration and operation of the communication network are described.

Chapter IV, Communication Systems Shortfalls and Problems, outlines the deficiencies noted in the systems presented in the preceding chapter. This is followed by Chapter V, which discusses the "quick fix" solutions to resolve the communications problem.

Chapter VI identifies the perceived future mission of PMRF, Barking Sands, and the requirements that this mission will place upon the system. A "big picture" approach is taken in establishing a ten year information system master plan. The final chapter will offer conclusions derived from the research.

II. MISSION AND OPERATIONS OF PMRF

A. INTRODUCTION

PMRF, Barking Sands, Hawaii, is the largest and most complete three- dimensional training and testing environment available to support Navy sea range operational testing. It is a directorate of the PMTC, Point Mugu, California, which is a subordinate command of the Naval Air Systems Command (NAVAIRSYSCOM), Washington, D.C. PMRF is operated autonomously to support Pacific Fleet elements, Air Force, Army, Marine, and allied programs. It supports a wide variety of training exercises in addition to research, development, test and evaluation (RDT&E) programs involving air, surface and sub-surface weapon systems.

B. MISSION

The PMRF is responsible for developing, maintaining, and operating a training range in which multi-threat scenarios can be used to meet current and future Fleet training requirements. PMRF's stated mission is to provide major range, operational, and base support for fleet users and other Department of Defense (DOD) and government agencies as assigned by the Commander, Pacific Missile Test Center. [Ref. 4:p. 4]

C. LOCATION

Barking Sands, the PMRF headquarters, is located on the west coast of the island of Kauai, Hawaii, about 120 nautical miles northwest of the island of Oahu. The PMRF ranges are ideally situated to provide training facilities for fleet users operating out of Pearl Harbor, as well as being centrally located to service all Pacific Fleet units. The main sites on Kauai include the headquarters at Barking Sands, a tracking station at Makaha Ridge, a communication site at Kokee Park, and the harbor facilities at Port Allen. Additional communication sites and support facilities are located on the islands of Niihau and Oahu. Figure 1 depicts the overall layout of PMRF. [Ref. 4: p. 2]

In addition to the areas depicted in Figure 1, PMRF operates and maintains two off-shore underwater range areas. These are the 120 square mile Barking Sands Tactical Underwater Range (BARSTUR) and the 880 square mile Barking Sands Underwater Range Expansion (BSURE). Figure 2 indicates the location of these ranges. The depth of these ranges combined with their expansive dimensions provide features and capabilities that are exclusive to PMRF. [Ref. 4:p. 3] Extensive air, surface, and underwater instrumentation coupled with real time computing and display systems creates an environment which transforms PMRF into one of the truly unique ranges in the world.

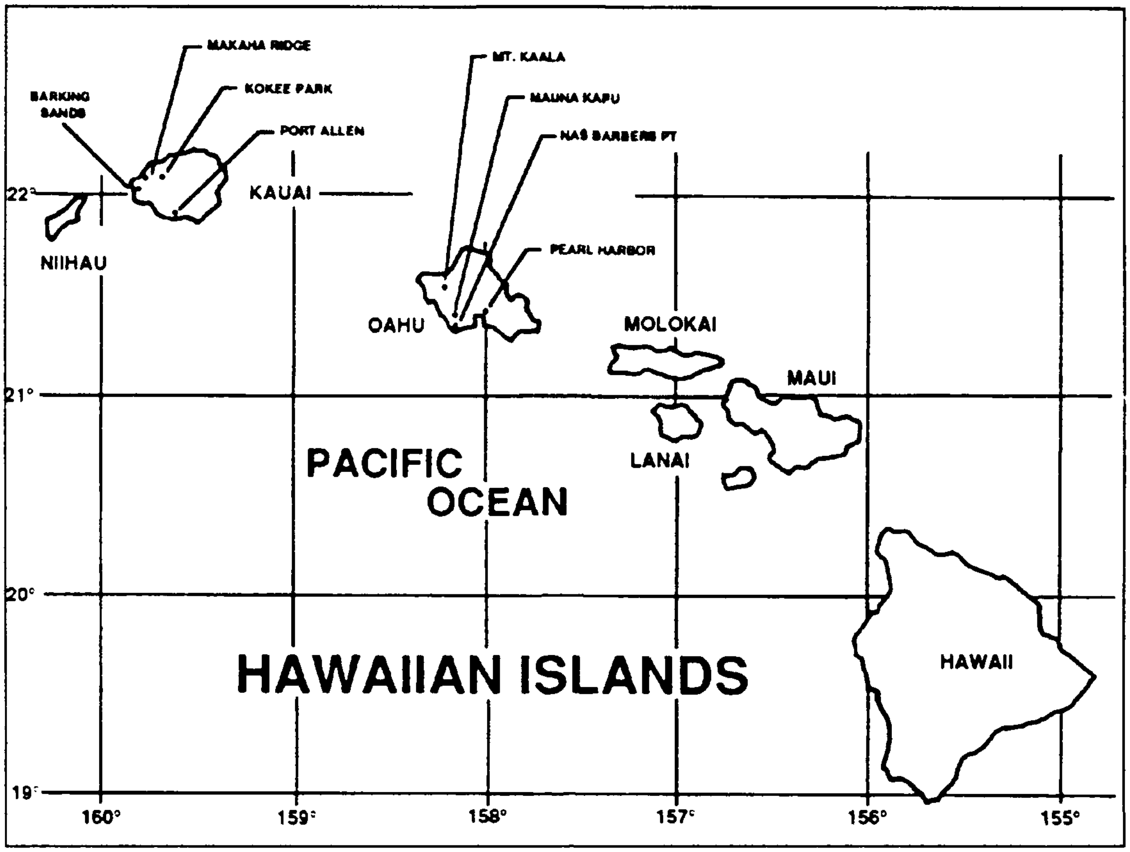

Figure 1: Location of PMRF

D. COMMUNICATIONS SYSTEMS

The communication systems installed at PMRF are categorized as either Range Communication Systems (RCS) or Defense Communication Systems (DCS). The RCS are specialized telecommunications, microwave, radio, closed circuit, and underwater systems required to fulfill range operational requirements. The DCS connect into the Kauai commercial telephone system and satellite links into Oahu and PMTC telephone systems to provide communications with outside

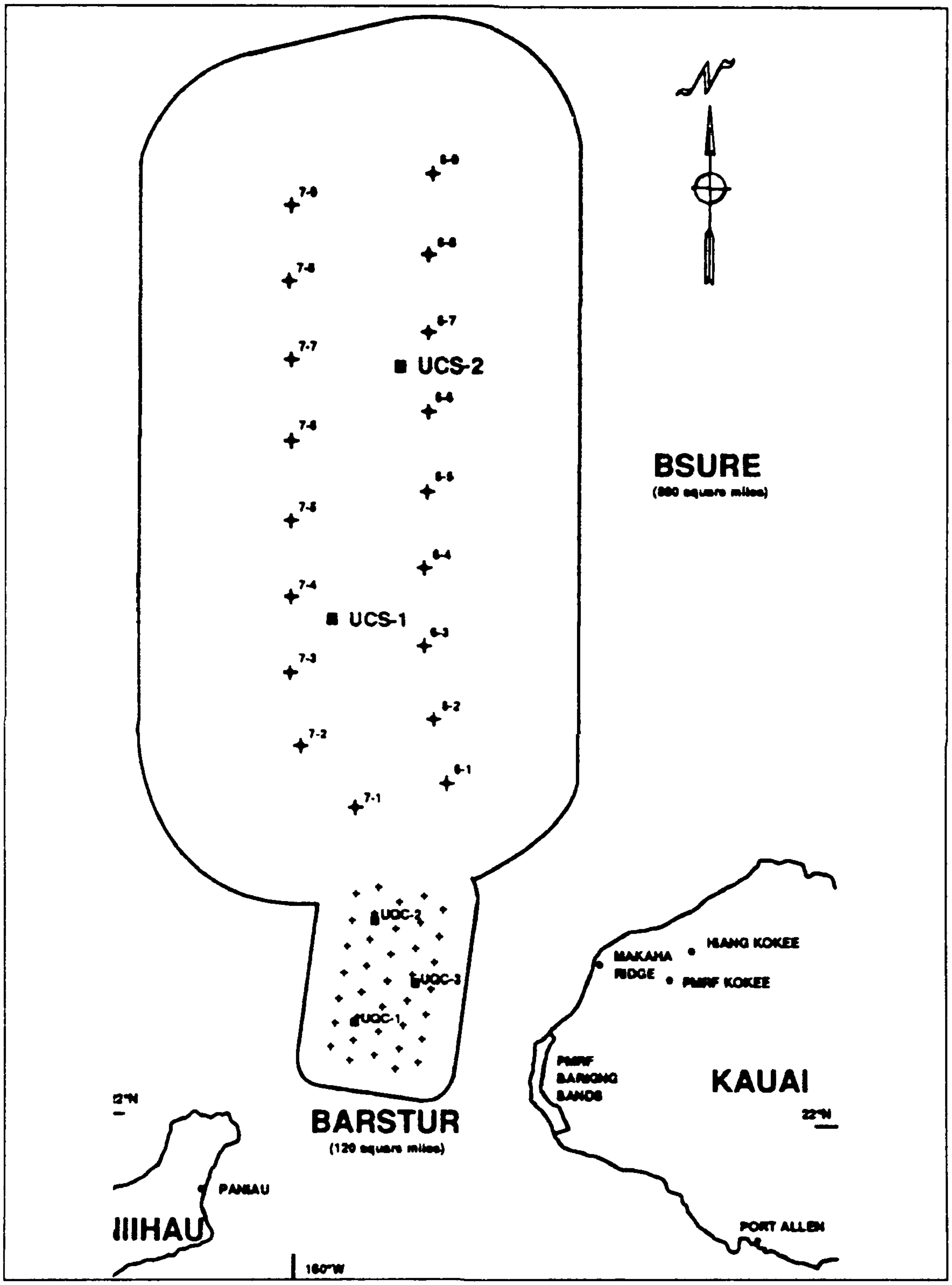

Figure 2: PMRF Ranges

government agencies and commercial businesses. Most of this equipment is commercial and subject to deregulation and competition. Although the RCS and DCS are separate and distinct from one another, the systems are interconnected and interoperable.

The telecommunication systems transmit voice and data signals between range sites and users. Transmission media include wire, radio, microwave and light. The microwave and satellite circuits are linked with PMTC in California and the Wheeler Network Communication Center (WNCC) situated at Wheeler Air Force Base, Oahu. Voice and data transmitted through the WNCC can access continental U.S. and Western Pacific ranges.

E. CURRENT OPERATIONS

The primary business of PMRF is to conduct safe, realistic, and effective training operations for range users in accordance with current national range program objectives. It provides support to Fleet users engaged in Fleet Training Group refresher, predeployment, annual multithreat and special training exercises. PMRF provides a fully instrumented range for anti-submarine warfare (ASW), electronic warfare (EW), anti-air warfare (AAW), and Navy operational and technical evaluation programs. Additionally, the facility provides instrumentation for other DOD agencies and a number of non-DOD government users [Ref. 4:p. 16]. Figure 3 is a graphic representation of the various operations conducted on the range.

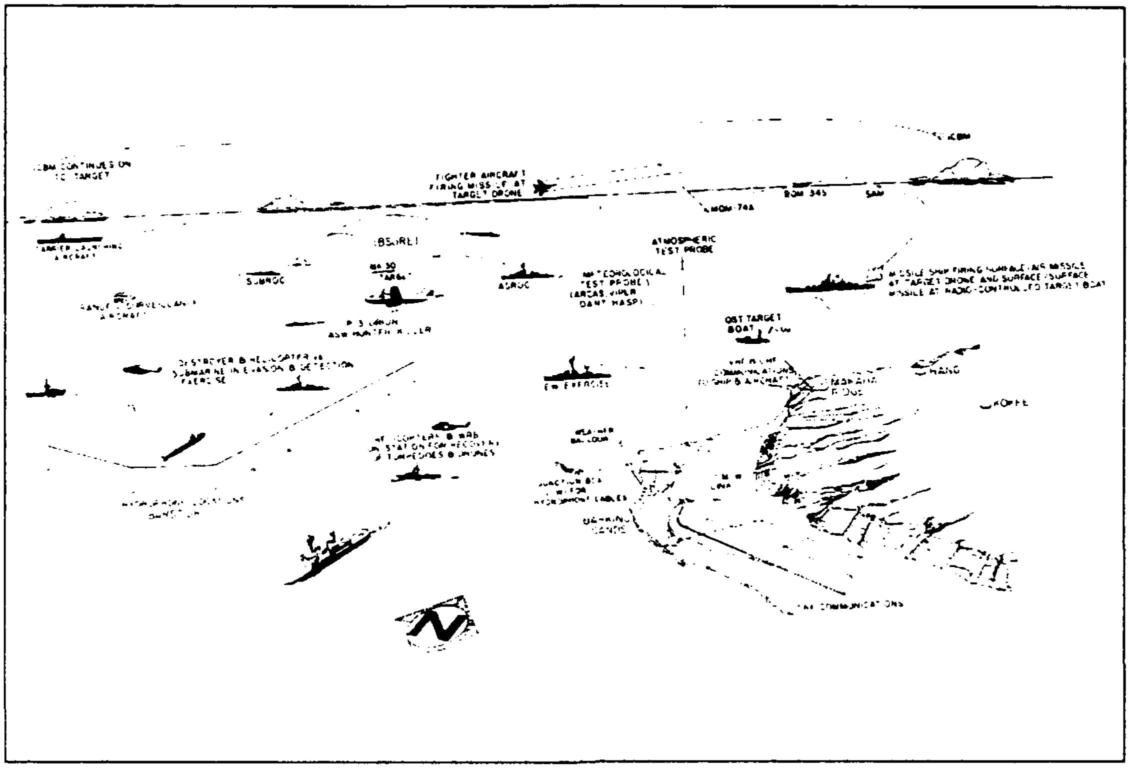

Figure 3: Typical Range Operations

Range operations center around pre-operational efforts such as planning, documentation and briefings, data reduction, and data analysis. In accomplishing this mission, PMRF performs a wide variety of functions associated with coordinating and conducting operations. Operational support functions performed include: ·

- range scheduling and area assignments
- frequency assignments and monitoring control
- telemetry

- radar
- electronic warfare
- underwater tracking and control
- data recording and reduction
- target launch and control
- weapon and target recovery

The support functions are determined by requirements submitted in the range users' Program Introduction (PI). Normal range services are provided as requested, or support services can be tailored to the specific needs of the individual unit. These services are provided on a direct cost basis to the user.

All operations and range control activities are centralized in the Range Operations Control Center (ROCC) located in Building 105 at Barking Sands. Three Tracking and Control (T&C) rooms, a Battle Management Interoperability Center (BMIC), and the Real Time Computer Center (RTCC) are located within the ROCC. Additionally, Facility Control, which is the communications heart of the range, the message center, and command and control system are located in the ROCC. All voice and data communications networks that interconnect the PMRF resources and project craft to provide the support capability for range operations are terminated in the ROCC. During operations, representatives of the government, contractor, and the range user are available in the control center.

III. CURRENT COMMUNICATION SYSTEMS AND FACILITIES

The communication system is a vital support function at the PMRF. Communication is used for coordination and transmission of data during the operations and for administrative and logistical support required by the instrumentation systems and the personnel engaged in the operation of the system. [Ref. 5:p. 3]

In this section, we will describe the major communication system capabilities at the PMRF, followed by the communication facilities. The systems discussed are microwave communications, RF communications, satellite communications, secure voice communications, telecommunication systems, underwater communications, frequency interference control systems, and the closed loop television system. The facilities described are the facility control at Barking Sands, the transceiver site at Kokole Point, the Makaha Ridge communication site, the Hawaiian Air National Guard (HIANG) site at Kokee, the Mauna Kapu frequency surveillance site, and the message center at Barking Sands. Figure 4 shows the communication interface between the different facilities at PMRF [Ref. 6:p. 8].

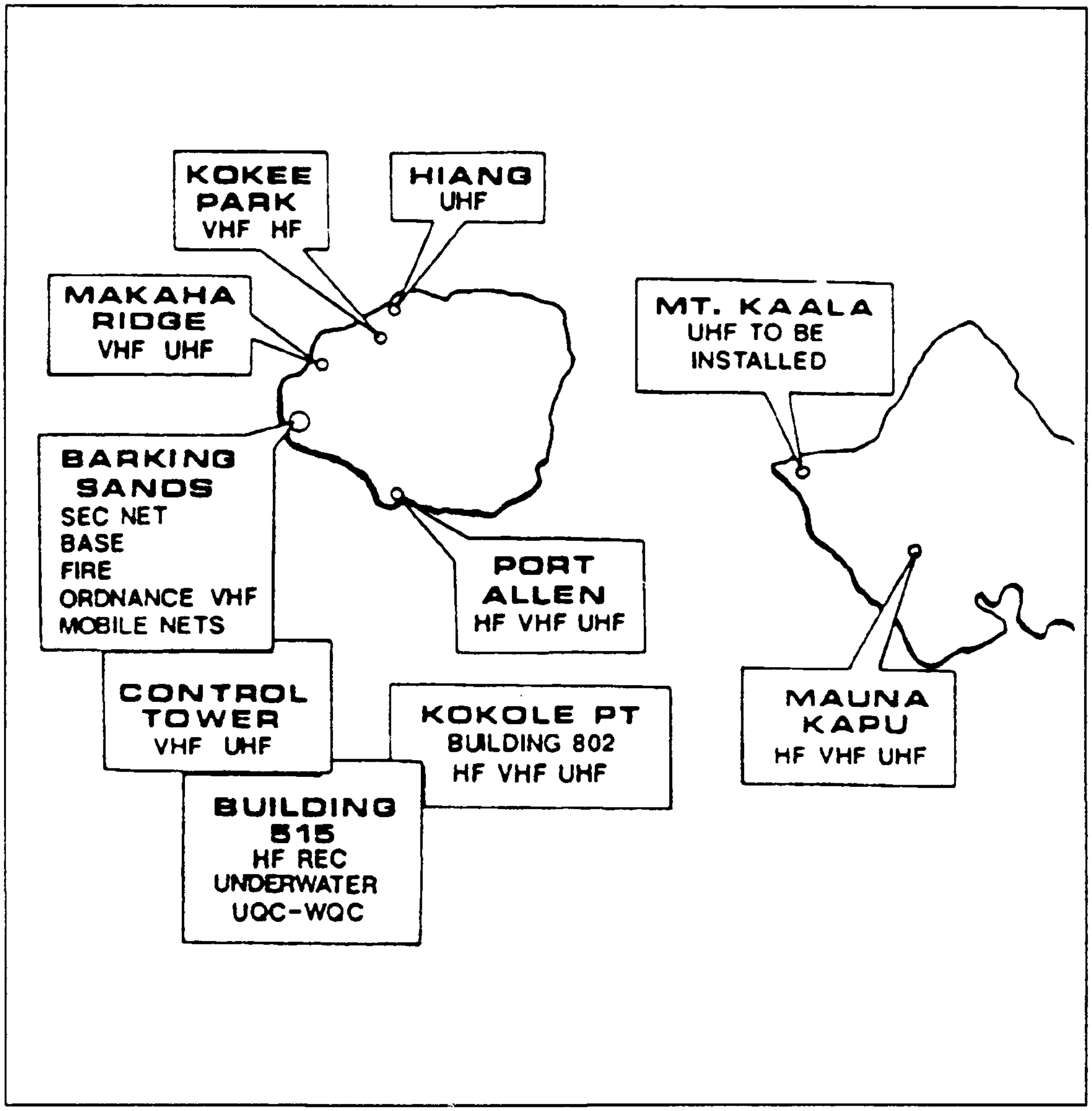

Figure 4: RF Communications Interface

A. COMMUNICATION SYSTEM CAPABILITIES

1. Microwave System

There are five independent microwave systems at PMRF which provide voice and data communications between facility control at Barking Sands to the outlying instrumentation sites such as Makaha Ridge, Kokee and the HIANG facility at Kokee:

- a wideband microwave system serving Niihau Island remotely controls operation of the AN/APS-134 surveillance radar, and provides relay of digitized radar data, control data and voice between the remotely operated, unmanned radar on Niihau Island and Barking Sands Building 105
- a microwave link which relays TV video from cameras at the launch area missile assembly (MAB) building to the TV video switch in Building 105
- an analog microwave link serving Makaha Ridge relays voice/data, telemetry, secure voice, and intermediate tracking control system (ITCS) data between Makaha Ridge and Barking Sands
- a digital microwave link serving HIANG Kokee and the Kokee communication site provides relay of voice and data between the Kokee communication site and Barking Sands and between Barking Sands and HIANG Kokee
- a microwave system linking the HIANG facility at Kokee to Oahu relays signals from the HIANG Kokee site to the Kukui Tower, from the Kukui Tower to Mt. Kaala, from Mt. Kaala to Makalapa, and then into Wheeler AFB. [Ref. 4:p. 64]

Figure 5 shows the different microwave system link interfaces between the PMRF and other facilities previously mentioned [Ref. 6:p. 2].

2. Radio Frequency Communication System

The Radio Frequency (RF) communication system provides for the transmission and reception of voice or electromagnetic data communications between the range users, operation control centers, and supporting range systems. RF communications are used for range safety control and operations coordination, administrative and logistical support, and transmission of

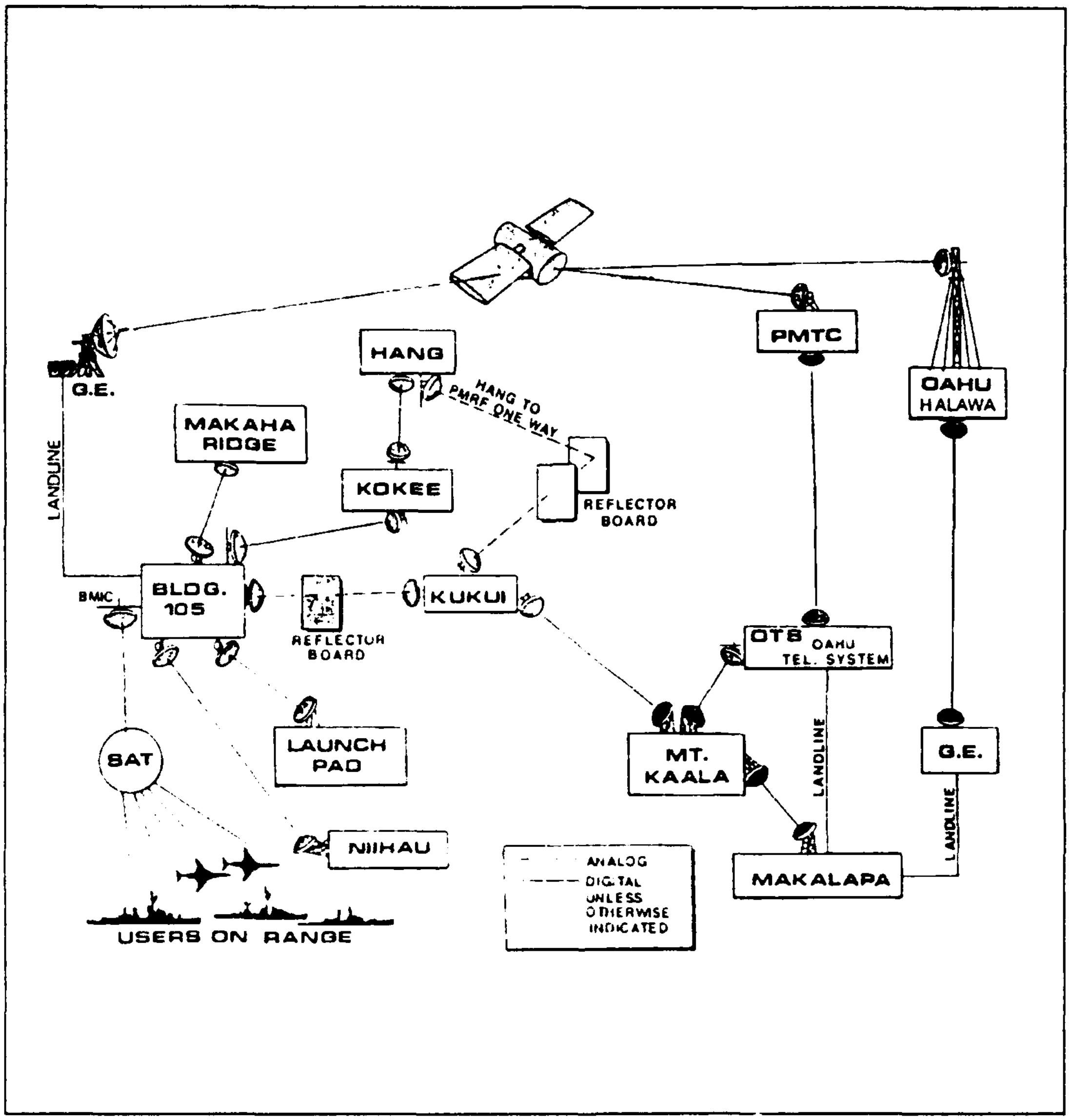

Figure 5: Microwave Link Interface

encrypted classified operational instructions and systems data. [Ref. 5:p. 6]

The receivers and transmitters in the RF communications systems are capable of operating in the HF, VHF, and UHF frequency bands, in the AM/FM/SSB, and FSK modes. HF radio equipment at Barking Sands is located at Kokole Point in Building 802 and in the Nohili area in Building 515. HF is the primary frequency band utilized to support today's fleet communications requirements on the range. PMRF currently operates a total of 19 HF transceivers, of which three are dedicated to the United States Air Force (USAF), and an additional three are dedicated to Navy Tactical Data System (NTDS) operational usage [Ref. 7:p. 3-1]. Receiving equipment located at Barking Sands and Kokee communication facilities detects electromagnetic signals and relays intelligence in the form of voice, radioteletype, or encrypted signals through the cable plant and/or the microwave data link systems to Barking Sands Facility Control. Patching networks at Facility Control are used to select appropriate transmitters or receiving equipment and enable RF systems to be remotely keyed from Tracking and Control (T&C) Alpha, Bravo or Charlie, or other areas as operations dictate. A variety of frequencies can be selected with different modulation modes [Ref. 5:p. 7].

The primary radio communication equipment for operations is VHF/UHF radios at Kokee, Makaha Ridge, and Mt. Kaala. Line of sight surface coverage from Kokee is 90 nautical miles. Surface coverage from Makaha Ridge is 60 nautical miles [Ref. 4:p. 63]. UHF radios on Mt. Kaala are remotely operated from Barking Sands via a microwave link. These radios provide coverage between the islands of Kauai and Oahu and a means of verifying radio circuit integrity with

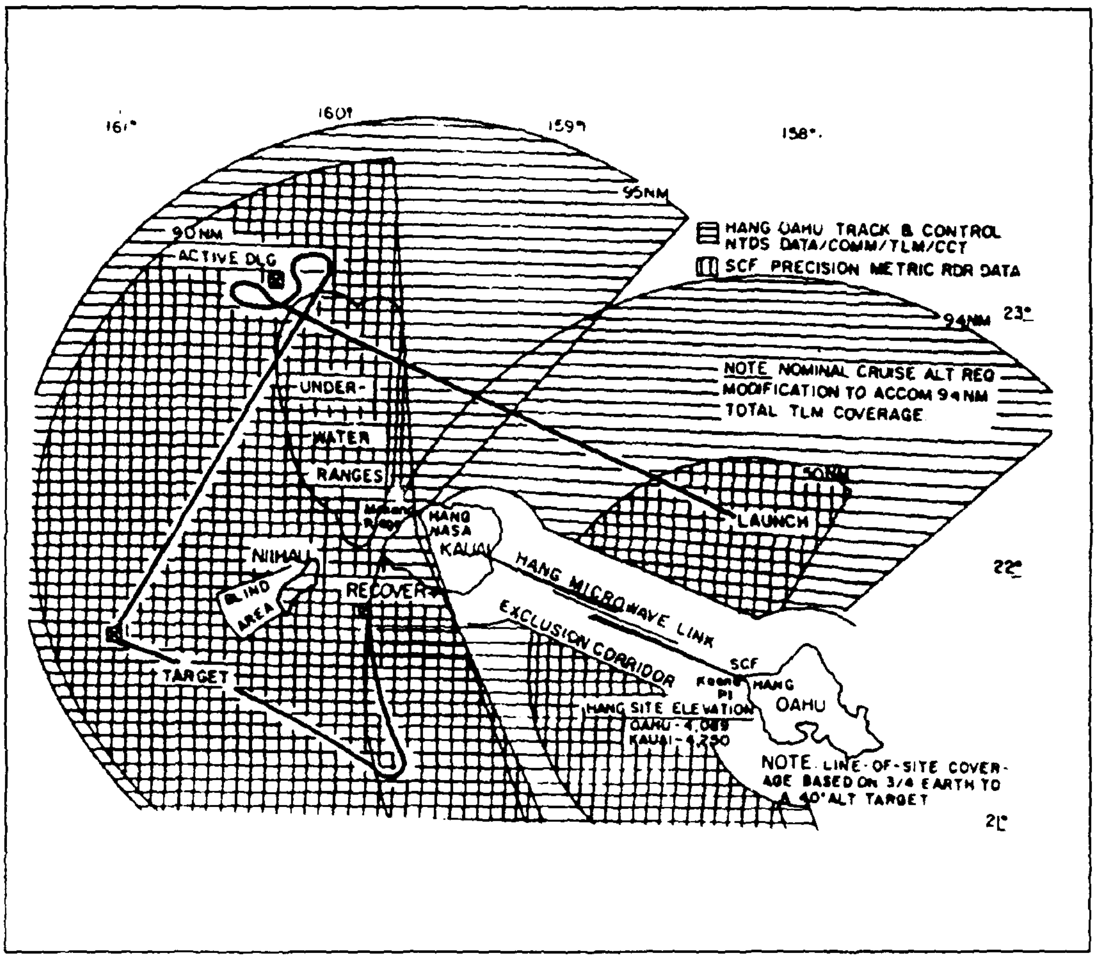

Figure 6: Line-of-Sight Coverage

ships in Pearl Harbor. Figure 6 shows the line of sight coverage from Makaha Ridge, Kokee, Kauai and Mt. Kaala to the entire training range [Ref. 8:p. 3].

3. Satellite Communication Systems

PMRF can communicate with the Fleet by use of the Fleet Satellite Communication (FLTSATCOM) installation at Barking Sands, Building 105. Two leased satellite links provide digital voice and data channels between PMRF and

Makalapa on Oahu and between PMRF and the Pacific Missile Test Center (PMTC) at Point Mugu, California [Ref. 4:p. 66]. Figure 7 shows the satellite communication interface between PMRF, Oahu, and PMTC [Ref. 9:p. 5].

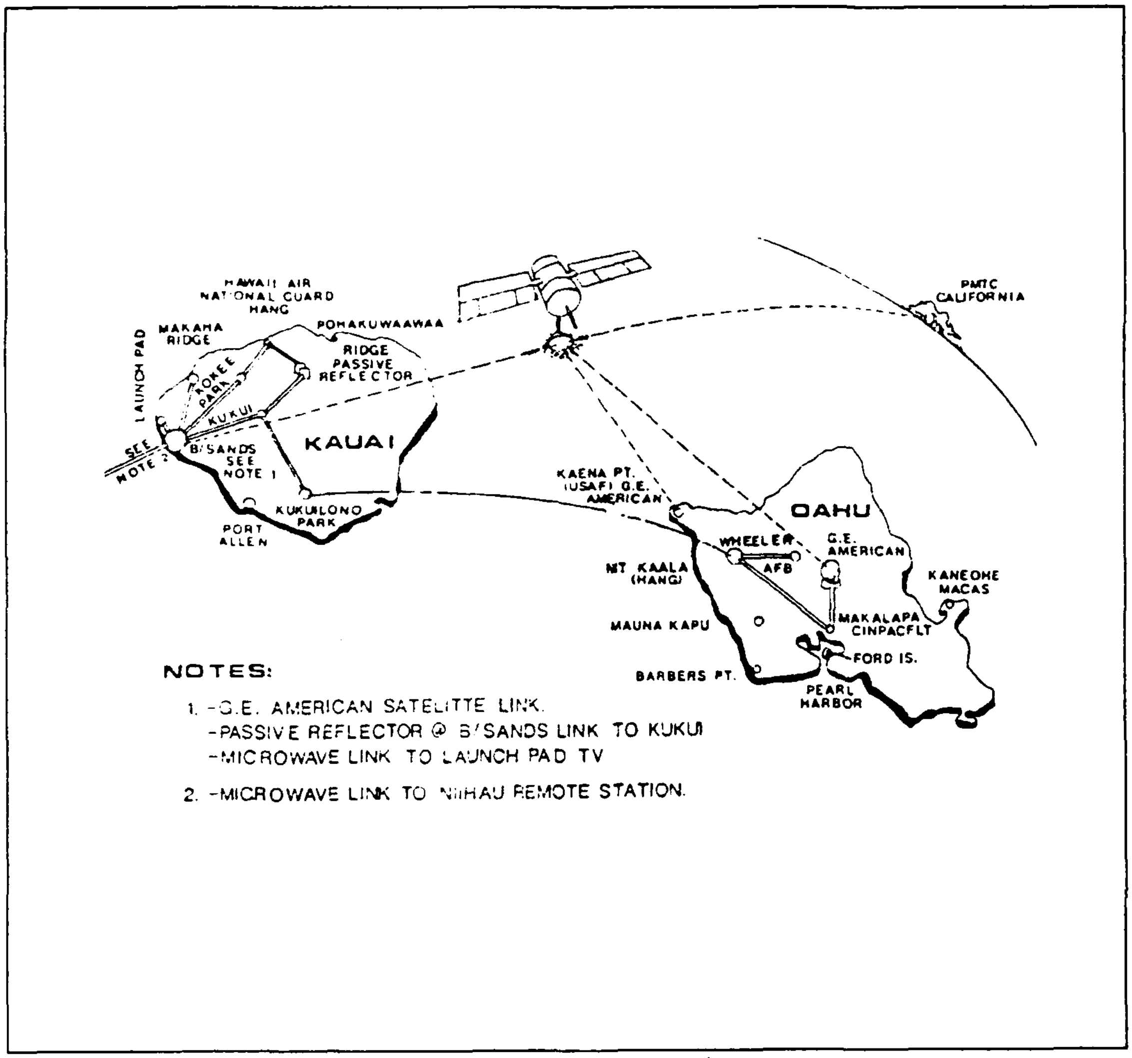

Figure 7: Satellite Communications Link

a. FLTSATCOM

The fleet satellite communication system provides relay secure voice and data over government UHF satellites using 25 Khz Navy assigned channels. It consists of AN/WSC-3 transceivers, CU-3333 vocoders, AM-6691A antenna duplexer, ON-143 crypto interface, KG-36 crypto equipment and USQ-81 data terminal. [Ref. 5:p. 9]

b. Leased Satellite Links

The satellite circuit, leased from General Electric Inc., consists of two separate T1 (1.544 MB/s) satellite links, one terminating at Pacific Missile Test Center (PMTC), Point Mugu, California and the other at Makalapa, Oahu. The Oahu link is extended to Pearl Harbor via a digital microwave link and land lines. Both links are equipped with Timeplex multiplex units with a common node at Barking Sands. The Timeplex multiplexer provides a variety of voice and data interfaces with dynamic system reconfiguration remotely controlled from the Barking Sands node. System monitoring and status reporting are also provided. [Ref. 5: p. 10]

4. Secure Voice System

Secure voice radio communications are available in all control room centers for classified HF, VHF, UHF and FLTSATCOM voice communications. [Ref. 4:p. 63] The secure voice system has the capability of transmitting and receiving eight secure voice frequencies simultaneously. This system permits classified communication with the range user ships and aircraft that are similarly equipped with encrypting devices.

The encrypting and switching equipment is located in the message center, Building 105, and the telemetry building at Makaha Ridge. Secure audio communications are routed to the control spaces in Building 105. Encrypted signals are transmitted and received through wideband RF equipment located at the transceiver site or Makaha Ridge. The appropriate transmitting/receiving site is selected according to the area of coverage desired by the range user. [Ref. 5:p. 12]

Two encrypted voice circuits are available for communications from the telemetry building at Makaha Ridge to range ships and aircraft. These circuits are connected via land line to Makaha Ridge from range participants. This system is used for secure voice communications for project observers at the telemetry facility. [Ref. 5:p. 12]

5. Telecommunication Systems

The telecommunications system provides voice operational networks for exercise participant units in the operational areas. Over 240 circuits can be cross-patched in Facility Control to configure networks. End station circuits are connected to the central patch-bay in Facility Control. Patching, mixing and amplifying provisions within Facility Control allow network configurations to satisfy widely varying requirements. A cross-patching capability using four, six and twelve leg bridging circuits can be provided to establish separate communication loops for the various participants in the instrumentation systems [Ref. 5:p. 15]. These separate loops are useful during periods when multiple operations are being supported.

Control consoles in Tracking and Control (T&C) Alpha, Bravo and Charlie are used to provide a single operator with the ability to communicate with many stations. There are twenty communication channels that may be patched at Facility Control to an individual station circuit or network.

Radio transfer circuits and switching units at Facility Control are used to interface RF receivers and transmitters with end station circuits. Operational units can be patched to remotely keyed transmitters located at Makaha Ridge and the Kokee transmitter site. Control consoles can also be configured for RF communications. [Ref. 5:p. 15]

A four-wire interface circuit is also provided to cross-connect the operational units to the Hawaiian Telephone Company or government telephone carriers. Commercial leased lines are used for communication with remote sites involved in combined services operations. The operational networks can be extended to range instrumentation sites located throughout the Hawaiian Islands and the Point Mugu facilities in California. These networks can also be connected with other worldwide networks through the Wheeler Air Force Station on Oahu.

6. Underwater Communication Systems

Underwater communications may be established with submerged or surface craft. Underwater tracking ranges and underwater communications can also be established through a transmitted RF link to either of the Weapons Recovery Boats (WRB) which are equipped with UQC underwater projectors. The transmitted signal from the ship on the range is received through any of the 37 BARSTUR or 15 BSURE range hydrophones [Ref. 5:p. 20]. Thus, underwater communication is available throughout the BARSTUR and BSURE ranges, although the latter is dependent on the availability of a WRB on the BSURE ranges.

The underwater communication system (UQC) for the BARSTUR range consists of a hydrophone selector and control unit located in the T&C Bravo, UQC receivers and isolation amplifiers in Facility Control plus the underwater projectors and the hydrophones. The selector and control unit allow the range user to patch up to 20 of the 52 hydrophones for reception of underwater signals from both range areas. Two control units provide a capability of operating two underwater communication systems simultaneously [Ref. 5:p. 20].

The voice signal inputs to the control unit are translated to an audio RF range of 8 to 12 KHz and transmitted through the BARSTUR underwater projector to ships on the range. When underwater communication through a WRB is used, the voice signal is transmitted via microwave from Facility

Control (Fac Control) to the Makaha Ridge communication facility. The voice signal is transmitted from Makaha Ridge Communication over a VHF RF link to the WRB where the signal is translated to the 8 to 12 KHz audio range. Whereas selected stationary hydrophones are normally used to receive the ship's signals on the range, the audio signals also can be received on the WRB. [Ref. 5:p. 21] This capability can be used for communication checkouts when desired. The ship's transmissions also can be relayed from the WRB to the shore when the ship is out of range of the hydrophones. The ships on the range transmit similarly translated audio signals which are monitored by the preselected hydrophone, amplified and received by the UQC receivers in Fac Control.

Another dimension of the UQC systems is for control of underwater systems. An example of such control is the Naval Underwater Weapons Engineering Station (NUWES) Acoustical Link (ACL). The ACL is used by the NUWES personnel to control underwater targets from T&C Bravo. Coded tone frequencies generated by the ACL are transmitted over the UQC systems to the targets for control purposes [Ref. 5:p. 21]. Transmitted output power nominally provides reception from submarines up to 20 miles from bottom mounted projectors. Transmissions from submarines can be received at distances from twelve to fifteen miles from a hydrophone [Ref. 4:p. 65].

7. Frequency Interference Control Systems

Frequency Interference Control (FIC) at PMRF is performed at two sites. Its functions are general surveillance, frequency measurement, and protection of range user frequencies from interference during operations. These sites are located at Makaha Ridge, Kauai and at Mauna Kapu, Oahu.

a. Makaha Ridge FIC

The Makaha Ridge FIC system is equipped with antennas, receivers, magnetic tape recorders, frequency converters and patch panels. The FIC system covers the 500 KHz to 12 GHz frequency range with two equipment groups. These are referred to as the radio frequency and the radar frequency groups. The radio frequency group includes frequencies in the range from 500 KHz to 2.3 GHz. The radar frequency group covers frequencies from 90 MHz to 10.75 GHz. Pulse width and pulse repetition frequency (PRF) measurements are accomplished in this frequency band. [Ref. 5:p. 28]

b. Mauna Kapu FIC

The Mauna Kapu FIC System, located at an elevation of 2000 feet on Oahu, and the Mobile Chase Van provide frequency coverage from 100 KHz to 18 GHz. Spectrum surveillance, frequency determinations and bandwidth measurement are performed by this system. Equipment at both stations can measure frequency, bandwidth, pulse width, PRF, percent modulation and FM modulation [Ref. 5:p. 29]. Over half of the station antennas are directional and can acquire azimuth and elevation of frequencies within range.

The Mobile Chase Van, used primarily in the vicinity of Pearl Harbor and Barbers Point, can be taken to any area that is accessible by road. Two interference systems monitor frequencies from 50 KHz to 18 GHz. The van is equipped with radio communications and an uninterrupted power supply (UPS) rated for 24 hour operation. [Ref. 4:p. 69]

8. Closed Circuit Television Systems

There are three closed circuit television systems at the PMRF. Four closed loop television cameras are in the launch missile assembly area (MAB), one camera is on the roof of the Operations Control Center, and four cameras are in the tracking and control (T&C) rooms Alpha and Bravo, located in Building 105, at Barking Sands. [Ref. 4:p. 68]

The launch area and rooftop cameras are used by the PMRF Launch Control Officer (LCO) or the Drone Control Officer (DCO) for range control and surveillance during launch exercises. Video outputs from these cameras are transmitted to the Operations Control Center via microwave. The video is also displayed in T&C Alpha, T&C Bravo and in Range Control. [Ref. 4:p. 68]

The T&C room cameras are used to monitor operations and produce documentary video tape records of any particular exercise that is in progress. The Alpha camera is controlled from within the Range Control room. This camera is used by the Range Control Officer (RCO) to monitor the operational activities within T&C Alpha. The T&C Bravo camera is controlled from the underwater tracking signal processing center, and it is used to monitor operational participant locations with respect to hydrophone instrumentation. [Ref. 4:p. 68]

B. FACILITIES

1. Facility Control

Facility Control (Fac Control) is located in the Range Operations Center, Building 105, Barking Sands and is the routing center of all the range communications systems. These include the circuits that originate and terminate within the PMRF plus other commercial, military or mobile communication systems. Radio frequency communication circuits and underwater communication circuits also terminate in Fac Control. Microwave antennas mounted on a tower adjacent to Building 105 link Fac Control to Makaha Ridge, the missile launch area, and to the Kokee site. [Ref. 5:p. 41]

The operational communication networks can be extended to remote points using the microwave system. Fac Control can also coordinate and establish communication links to ships and aircraft participating in range operations using RF communication circuits. These circuits are routed to the transmitter site at Barking Sands or, by microwave, to the Kokee communication site. These operational telecommunication/microwave/RF communication networks are used for coordination between the operation participants and the instrumentation system controllers. Fac Control can also route operational networks to other instrumentation ranges. These circuits are patched and routed over established military communication circuits, by satellite, or by high frequency RF links. The military circuits are established via Wheeler Air Force Base on Oahu. The transmission to Oahu is via leased lines from the Hawaiian Telephone Company. [Ref. 5:p. 42]

Inter-range circuits can be used during long range missile launches which require coordination of the instrumentation systems at Barking Sands with Point Mugu, California; Kaena Point, Hawaii; and others. The RF links use transmitters and receivers at Barking Sands [Ref. 5:p. 42]. The teletype circuits going to and from the message center are also routed through Fac Control. The terminal equipments, repeaters, converters, power supplies and patching facilities associated with the teletype circuits are also located in Fac Control.

2. Kokole Point Transceiver Site

The transceiver site located at Kokole Point houses a complete system to provide HF/VHF/UHF voice and data communications for the range users. Two 300 KW power generators are located adjacent to the transceiver site to provide standby power during power outages.

The transceiver building contain both transmitting and receiving equipments. These systems use antennas located in the immediate vicinity of the transceiver site. These systems receive the RF signals which are then routed through the cable plant to Fac Control and patched to the end user circuits. The user can remotely key transmitters at the transceiver site by employing the Fac Control patch bay and radio transfer circuits. [Ref. 5:p. 46]

3. Makaha Ridge Communication Site

The Makaha Ridge UHF/VHF communication site has an elevation of 1500 feet above sea level and is located at the Makaha Ridge complex, Building 708, of the PMRF. The Makaha Ridge Communication site currently provides range users with VHF and UHF ship to shore and air to ground communications. It also provides PMRF with narrowband and wideband short range, line of sight (LOS) voice communication with range users [Ref. 10:p. 42]. This site is the primary operational routing center for instrumentation sites at Makaha Ridge and contains associated patching networks, cable plant, and transfer circuits for the end user system. A microwave system provides a data/communications link between Barking Sands and Makaha Ridge. The Makaha Ridge communications site also contains frequency interference control equipment that covers frequencies from 0.5 MHz to 12 GHz.

A sonobuoy receiving system is also located at the Makaha Ridge communications site. This consists of a bank of four four-channel receivers to receive up to 16 sonobuoy channels. Narrowband magnetic tape recordings of these outputs can be made at the communication building. The receiver outputs may also be patched to the telemetry building at Makaha Ridge for wideband magnetic tape recording. The receiver outputs can also be transmitted via microwave to Fac Control at Barking Sands. [Ref. 5:p. 49]

4. Kokee Communication Site

The range control frequencies for PMRF are transmitted and received by equipment housed in a CONEX van located at the HIANG site at Kokee. The 4,000 feet elevation communication site extends the VHF/UHF voice communications range and area coverage from this location.

UHF communications are provided by three GRT-20 transmitters and three R-1533/URR receivers. A 20 watt transceiver is used for VHF voice communication frequencies. Audio intelligence is received and transmitted at the Kokee communication site and relayed through the HIANG Kokee and

Barking Sands microwave communication systems to Facility Control center at Barking Sands, Kauai. [Ref. 5:p. 52]

5. Mauna Kapu Frequency Surveillance Site

The Mauna Kapu Frequency Surveillance Site is near the summit of Mauna Kapu, Oahu. It is approximately 10 miles west of Pearl Harbor behind NAS Barbers Point. The Mauna Kapu site functions include frequency management through detection and evaluation of radio frequency interference and support of fleet electronic warfare exercises. Additional functions include support of ASW Frigate Lamps Integrated Team Training (FLITT). [Ref. 5:p. 53]

6. Barking Sands Message Center

The message center, Building 105, handles the teletype message traffic received or generated at PMRF. It is located in the Range Operations Center at Barking Sands. This facility is operated 24 hours per day, seven days a week. The Barking Sands message center is a tributary station of the DOD common user network and is connected with the Naval Communication Station, Honolulu (NCSH), Wahiawa, Oahu, and the Western Region Control Center (WRCC) at Wheeler AFB, Oahu. The message center handles both administrative and operational messages. It is also equipped to handle classified encrypted traffic.

The message center receives all incoming traffic and routes messages to the proper offices at PMRF. Outgoing traffic is first reproduced on perforated teletype tape and then transmitted via AUTODIN to its proper destination. Files of all incoming and outgoing traffic are maintained. The transfer of message traffic between the message center and the various local offices is handled over the counter at the message center.

Teletype machines are installed in areas other than the message center. Machines are installed in the Tracking and Control rooms and are used for operational type traffic during operations. The teletypes in the computer room are used for traffic that is used to update the computer programs [Ref. 5:p. 61]. Other machines are located throughout the base and are used primarily for non-classified, administrative traffic.

IV. CURRENT COMMUNICATIONS SYSTEM SHORTFALLS AND PROBLEMS

The PMRF communications system has some components that are very old and obsolete. Many of the underground copper cables are also very old and deteriorating. Fac Control has a very old analog patch panel system which is obsolete, difficult to maintain and succeptible to frequent failures. It is unable to select frequencies at operator positions, precluding keeping up with frequency changes within the fleet. PMRF also has limited capabilities to cover classified communication on the range. It is presently set up with only two different frequencies for crypto. With all this in mind, there is no doubt that demands for efficient communications to various locations have strained the current communication system to a point where it is unable to perform effectively and efficiently. The following is a detailed listing of several major deficiencies at PMRF in addition to those previously mentioned.

A. MICROWAVE COMMUNICATIONS

The microwave link between Makaha Ridge and Barking Sands consists of an analog system which is currently in use and is obsolete. This system was replaced eight years ago with a digital system, but the replacement had a few shortfalls. It is unable to transmit ITCS, secure voice wideband and telemetry signals [Ref. 7:p. 2-1]. Some individual channels have encryption equipment, however, it would be too expensive to provide encryption equipment for all 120 channels. Additionally, the existing equipment does not have the channel capacity that is required to support extensive range operations.

The microwave link between Kokee and Barking Sands is a digital system. The problems with this link show up in the area of telephone service, whereby there were no circuit cards provided for telephone services, and provisions for UHF/VHF radio circuits interfacing were very limited. This system also lacks the capability to transmit secure voice wideband and telemetry signals. [Ref. 7:p. 2-3]

The microwave link between Mt. Kaala and Makalapa is a new digital system. Technical problems such as back-up electrical power, electrical outlet plugs not secured, audio cable not installed, remote control equipment not operational and others remain to be resolved. [Ref. 7:p. 2-6]

B. HF/VHF/UHF RADIO COMMUNICATIONS

In FY 90-91, all obsolete HF transmitters and receivers were replaced; however, the obsolete antennas which are incompatible with the newer transceivers were not replaced. The Building 515 receiver site in the Nohili area is located along the line of sight of the MPS-25 radars and the STARs launching pad and there is concern that an array of high gain HF receiver antennas there would cause radar problems. [Ref. 7:p. 3-1]

The HF equipment located at Kokole Point, Barking Sands, needs to be relocated in order to expand HF range coverage. Presently, PMRF is unable to use HF circuits on the North Shore because of the location. Also the existing HF equipments are not capable of providing good quality secure voice communications.

The existing UHF circuits assigned to Mt. Kaala, Oahu are inadequate to support the various range users and will not provide the necessary UHF line of sight communication between participants and operation conductors. UHF coverage needs to be expanded out to 300-400 miles in order to support over the horizon (OTH) coverage. The Makaha Ridge UHF/VHF communication site is located at an elevation of only 1500 feet, and therefore does not provide present range users with adequate facilities for long range operations. PMRF also needs additional VHF or VHF FM frequencies for surface and P-3 patrol aircraft support. [Ref. 5:p. 7]

C. SATELLITE COMMUNICATIONS

The PMTC/PMRF link continuously has problems with the utilization of KG-34 crypto devices, but clear voice utilization is satisfactory [Ref. 7:p. 9-1]. The PMRF-Oahu link has given continuous problems caused by the Timeplex interface system. Circuit dropouts cause heavier use of commercial lines. [Ref. 7:p. 9-1]

D. FACILITY CONTROL PATCH PANEL

The old analog switching/patch panel in Fac Control presently used for range operations is obsolete and difficult to repair. It is very unreliable and requires frequent maintenance, causing interruptions during extensive range operations. This system has been modified and expanded a number of times. It supports two tracking and control rooms (T&C Alpha and Bravo) in Building 105 plus customers located outside the building. However, it provides limited capabilities to cover classified communication that are necessary at PMRF during range operations. The continued used of this analog patch panel makes range operations very inefficient.

E. WEAPONS RECOVERY BOATS RF COMMUNICATIONS

Secure and clear voice HF communication equipment is required aboard the weapons recovery boats primarily for communications with range operations control center to coordinate operations support requirements [Ref. 7:p. 3-7]. The equipment required for the boats was not planned for in previous communications upgrade programs, and therefore not much was accomplished in the past years with the exception of two HF radios which were requested in FY 88 as replacements for the units in the two support boats. These HF transceivers failed, and as an interim measure to provide HF capabilities for the boats, two Kenwood transceivers borrowed from the Range Control center are being utilized.

F. DENRO DIGITAL INTERCOMMUNICATIONS SYSTEM

The DENRO digital intercommunications system includes a digital switch, operator's control panels and six computers which will interface into Fac Control and the present telecommunication network, extending communications distribution into the new Tracking and Control (T&C) rooms in the Range Operations Building [Ref. 7:p. 4-1]. The DENRO system was to be operational in February 1990, however due to manufacturer design deficiencies and unsatisfactory testing, the system to date is non-operational. To date, the estimate for resolution of system deficiencies is unknown to the PMRF communications branch.

Although the computer control equipment is presently installed, provisions for its installation was not included in the initial installation plan. This led to continued reliance on the old analog patch panel and conferencing equipment now being used for range operations which are obsolete and difficult to repair.

At the time of the addition of the DENRO digital switch, funding was only available for enough capability to support the new T&C rooms. The digital switch had to be interconnected to the analog switch, which severely limited remote operators in their ability to select conferences as needed [Ref. 8:p. 3]. This process resulted in very labor-intensive and very tedious maintenance and repair efforts.

G. PMRF BASE TELEPHONE SYSTEM

The base telephone system includes the telephone switch, inside and outside cable plants, and the area paging system. The telephone switch is computer controlled and has a 600 line capability with automatic conferencing networks. There are 10 leased trunk lines which connect PMRF to the Pearl Harbor Private Branch Exchange (PBX), and a leased satellite link ties PMRF to PMTC with connectivity extended to the Point Mugu PBX. [Ref. 7:p. 5-1]

Cable plants are located at Barking Sands, Makaha Ridge and Kokee and are composed of fiber optics, copper, ethernet cables and data transmission cables [Ref. 7:p. 5-1]. High noise levels are being experienced in the base telephone system due to deteriorated cables. This high noise level has caused degradations in data transmissions, as well as dropouts and wrong number selection.

H. PMRF CABLE SYSTEM CONFIGURATION

The majority of the cable system installed throughout Barking Sands and adjoining facilities consists of very old copper cable from the early 1950's. It has severely deteriorated over time, mainly due to environmental conditions, until at present over 50% of the cable circuits are unreliable or inoperative [Ref. 10:p. 54]. These old copper cables are limited in their capabilities to handle the bandwidth required by today's modern day communications systems, and they also prevent the transmission of high quality, noise-free information. In some areas, service is very poor due to excessive noise and crosstalk. Digital data transmission becomes very difficult because of this interference. This present status of the cables, coupled with an ever increasing demand for more service and an exploding demand for data transmission, has placed PMRF in a critical operational position where they may face a catastrophic failure of range communications. Additionally, increasing demands cannot be met. [Ref. 10:p. 60]

I. LOCAL AREA NETWORKS (LANS)

There are presently several Local Area Networks (LANs) at PMRF, Barking Sands that are independent and cannot, at the present time, talk to each other. There is also a large number of Personal Computers (PCs) at the base that need to interact and share information. The amount of time lost in printing and distributing data among personnel and in converting data from one system to another is excessive and expensive [Ref. 8:p. 169]. The LANs do not have designated technical managers who can provide system monitoring, troubleshooting, and maintenance services. [Ref. 7: p. 6-1]

V. SHORT TERM COMMUNICATIONS PLAN

This chapter provides recommendations for the upgrading of the PMRF RF communication systems, microwave systems, satellite systems, Facility Control centralized control consoles, weapons recovery boats' RF systems, DENRO digital switch, base telephone, cable plant and Local Area Network (LAN) system. It will also bring together all elements of the various communications system shortfalls identified for improvement to support future expanded range operations.

A. MICROWAVE COMMUNICATIONS SYSTEM

1. Makaha Ridge to Barking Sands Microwave Link

The analog link currently used is obsolete and was to be replaced eight years ago with a digital link. Delays in conversion to the digital system will affect PMRF's ability to provide better support to the range users and to the fleet. Recent experiences with degraded quality of operations point out the need for this conversion [Ref. 7:p. 2-2]. Retaining the obsolete analog system will result in continued higher operational and maintenance costs. PMRF must take a very active role in the conversion of this analog system to a digital system in order to prevent continued degraded Fleet Battle Group operations support due to its obsolescence.

2. Kokee to Barking Sands Digital Microwave Link

The problems of this link are in the areas of telephone service and radio circuit interface. As an interim solution, telephone service has been established on this link by utilizing those circuit cards designated for the spare circuits in the fiber optics cable plant. Spares have not been purchased. As an interim solution to the radio circuit interfacing problem, circuit cards were cannibalized from the Makaha Ridge microwave system. [Ref. 7:p. 2-3]

Delays in resolving this system's shortfalls continue to affect PMRF's ability to provide efficient support to the fleet. Cannibalization of fiber optics system hardware will lead to degradation of the fiber optics system at PMRF. Lack of efficient VHF/UHF radio interface with other existing systems located presently at the Kokee site will prevent the consolidation of all VHF/UHF radios of PMRF to the Kokee communication site.

B. RF COMMUNICATIONS

1. UHF/VHF Communications at Makaha Ridge

PMRF primary UHF communications capability is provided by the Makaha Ridge communication site. This site provides the range with UHF line of sight communications out to approximately only 60 nautical miles. It also supports missile firing with launcher versus target range separations to a maximum distance of 120 nautical miles. However, the range maximum launches are constrained to north-south firing geometries due to the instrumentation coverage of this site [Ref. 9:p. 1]. Therefore, it is necessary to relocate the UHF/VHF communications equipment from Makaha Ridge to the Kokee site in order to provide this required flexibility and interface with the digital microwave system located at Kokee. This approach will allow PMRF to expand the range by taking advantage of the higher elevation at Kokee, which will extend the line of sight communications coverage by approximately 50% or out to 90 nautical miles.

2. HF Communications at Kokole Point, Barking Sands

Although the transceivers were replaced at this site, the project did not replace the obsolete antennas which are incompatible with the new transceivers. To resolve this antenna problem, a series of state-of-the-art antennas must be purchased and installed in order for PMRF to provide reliable HF and secure voice communications in support of Fleet Battle Group Operations [Ref. 7:p. 3-1]. HF communications is required to cover areas outside UHF range, since Battle Group Exercises can be held out to as far as 500 nautical miles away from PMRF. Not equipping the HF receivers with optimum antennas will result in PMRF continuing to provide degraded HF communications service to the Fleet.

PMRF must procure the necessary HF antennas with the required radiation patterns so that it can provide HF communications coverage to all areas needed for their operational support. This will include the flexibility to select any antenna, transmitter, or receiver, and be compatible with the frequency selected.

C. SATELLITE COMMUNICATIONS

There are two satellite links from PMRF. One is between PMRF and PMTC, Point Mugu California, and the other is between PMRF and Oahu. The unsatisfactory link quality in the Oahu link can be corrected by performing maintenance on the Timeplex system to correct the echo problems. This will prevent continued dissatisfaction for phone users and allow the circuit to be used for FAX and data transmission. This will then result in minimum use of commercial lines, thereby also reducing phone bills and other associated problems.

D. FACILITY CONTROL CENTRALIZED CONTROL CONSOLES

Centralized control consoles must be implemented in Fac Control in order to have centralized control of the digital switches for classified and unclassified voice transmission. In addition, these centralized control consoles could provide centralized control of video switching, multiple LAN interfaces and remote radios throughout the different facilities at Barking Sands [Ref. 8:p. 4]. Appropriate software development will be needed for these controlling functions.

These centralized control consoles will greatly reduce operator requirements, minimize manpower maintenance requirements and provide centralized information to and from a central local point. The main advantage of this centralized control console will be to allow the operators to respond quickly and efficiently to any operational request and allow them to assist or to substitute for each other in meeting the different range operational requirements. [Ref. 8:p. 5]

E. WEAPONS RECOVERY BOATS RF COMMUNICATIONS

HF secure and clear voice needs to be installed aboard the weapons recovery boats. Additionally, replacement of deteriorated secure/clear voice UHF transceivers and replacement of the remote control deck intercommunication system which controls the HF/VHF/UHF, and Underwater communications equipment must be performed [Ref. 7:p. 3-7]. If this task is not completed, the communications equipment on the weapons recovery boats will continue to degrade, thereby making the boats unable to respond to appropriate future operational tasking.

F. DENRO DIGITAL INTERCOMMUNICATION SWITCH

The old analog switching panel and conferencing equipment now being used for range operations is obsolete and difficult to repair. An expanded capability of the DENRO digital switch will make range operation much more efficient. It will give the range operators the ability to properly select the conference needed for a particular operation. [Ref. 8:p. 11]

PMRF should closely monitor the operation and maintenance of this system. All intercommunications networks should be cross-connected to the digital switch [Ref. 7:p. 4-1]. Closer liaison with the manufacturer is required on this project to ensure that continued efforts are made for successful operation of this system. Further delays in the operation of this system will result in degraded digital intercommunication capabilities at PMRF.

An expanded capability of the digital switch with the utilization of Operator Control Panels (OCP) will make range operation much more efficient. It will give the range operators the ability to properly select the conference they require for the desired operation [Ref. 7:p. 11]. Expansion of the digital DENRO switch capability will allow removing the old analog patch panel which is now used to interconnect the digital switch with analog communications systems serving the various remote operational stations [Ref. 8:p. 11].

G. PMRF BASE TELEPHONE SYSTEM

High noise levels are being experienced in the base telephone system due to deteriorated cables. All the copper cables must be removed and replaced by fiber optic cables. Additional fiber optic cable must be installed to complete the outside cable plant improvement at PMRF, and continued efforts are required to remove all excess indoor cables throughout the facilities at PMRF. [Ref. 7:p. 5-2]

In addition to cable replacement, the telephone switch must be expanded from 600 to 1000 lines. This will meet PMRF current requirements and allow for expansion [Ref. 7:p. 5-2]. If corrective action of this system continues to be delayed, the telephone system will continue to deteriorate and the problems of high noise, degraded data transmission, wrong number dialing, and dropouts will become much worse.

H. PMRF CABLE SYSTEM CONFIGURATION

There is a desperate need to install fiber optics throughout the PMRF facilities. The main reason is due to the old, deteriorated copper cables installed shortly after World War II. These old copper cables are unable to support the currently required capacity for data and voice transmission which are imposed by the range training requirements.

There are some fiber optic cables currently in place at PMRF. However, there are still a number of buildings with copper cables.

Single mode fiber is almost unlimited in terms of bandwidth requirements for the signal to be transmitted. It requires only the multiplexing equipment and drivers/receivers appropriate for the required signal. Therefore, fiber optics will provide the ability to meet the demand for wideband transmission. [Ref. 8:p. 15]

I. LOCAL AREA NETWORKS (LAN)

A requirement exists for the various computers, including almost all personal computers (PCs), to be interoperable. Interconnection of the various LANs must be made in order to allow the different computers and terminals at PMRF to share access to common resources, information and peer-level communications. The amount of time lost in distributing information among the different facilities will be greatly minimized.

The benefits of having an effective, operational LAN are numerous. LANs promise substantial cost savings in installation, maintenance and expansion. Therefore, close system monitoring, troubleshooting and maintenance/repair services of this system should be a necessity for expeditious transfer of information.

VI. FUTURE VISION AND TEN YEAR PLAN

Evolving technologies have forced the Navy to undertake a comprehensive restructuring of its Command and Control, Communications, and Computer (C4) strategy. In order to propel this strategy into the twenty-first century, the Navy must meet three challenges. First, the Navy must develop new technologies that integrate divergent systems, facilitate tactical decision-making, and alleviate communication capacity restrictions. The second challenge is to build and clearly articulate a new C4 architecture, organizational infrastructure, and doctrine that integrates both day-to-day training activities and modern war and crisis management. Finally, the Navy must adapt to the reduced manpower and funding levels mandated by Congress without a decrease in operational proficiency or performance. [Ref. 11:p. 7]

The Navy's Maritime Strategy provides the framework for applying sea power across all aspects of the potential spectrum of conflict. Since the strategy is the framework for the manner in which the Navy will fight, then it must also be the framework for the manner in which training is conducted. This point is reiterated at the highest level by the Director of Defense Information, Paul Strassman, who states that the DOD is in the war-winning business; therefore, the technical aspects of information management must be the same for training exercises as they are for actual combat missions [Ref. 12:p. 34]. This strategy is of particular importance to PMRF as it undertakes efforts to upgrade and modernize its communications and information systems. Resources that are to be employed must be selected with this concept in mind and they must contribute to the seamless integration of training and tactical information systems. It will require unique solutions to maintain the level of support and modernization of the recent past with the reduced manpower and funding levels predicted for the future.

A. FUTURE MISSION

As we progress further into the post Cold-War years, austerity in DOD will be the watchword. The consolidation of functions and the reduction in services will lead the way. PMRF will not be immune to the effects of these changes and must plan future actions accordingly. Already, a change in claimancy from NAVAIRSYSCOM to the Commander-in-Chief Pacific Fleet (CINCPACFLT) is underway that will mandate reorganization and vertical cuts. Additionally, the decline in the budget and budget-based transfers associated with the change in claimancy will reduce resource capabilities at PMRF and affect the levels of support provided to the Fleet, RDT&E and national range users.

The basic mission of PMRF--to plan, organize, and conduct sea, land, and air instrumentation operations in support of Fleet and DOD programs--will not change significantly in the future. However, the change in claimancy to CINCPACFLT will cause range operations to become more focused on operational training exercises and less on RDT&E and national programs. Conduct of the latter type of programs will be greatly reduced, and they will become supplementary missions for PMRF to support on a case-by-case-basis. Any requirements associated with these programs that exceed the capabilities of the installed systems must be provided by the requesting agency.

B. FUTURE VISION

PMRF range operations, as derived from the National Security Strategy, will continue to be tailored to meet user needs. Operations on and in support of the range will reflect a commitment to training using state-of-the-art command and control systems. These operations will be based on generic warfare scenarios available over the Defense Information System Network (DISN), and will be conducted in a manner that will make them indistinguishable to the users from current warfare tactics.

In order to accomplish this, PMRF must adopt a coordinated, integrated approach to range communication and to communication operation management. A systems architecture which will invisibly integrate both internal and external requirements for information must be the focus of the future. This approach will benefit PMRF by establishing technical standards that allow the purchase of required systems commercially off the shelf in a competitive environment.

Reductions in both manning and funding levels will necessitate a more centralized control of the distributed communication functions. Range operations will be conducted from a central room where the operators have access to and control of all communication functions. The development of a series of interchangeable operator control panels will allow a single operator to control and monitor all range activities or pass off control of certain functions to other controllers. The establishment of these control panels for the controlling of all switches, radios, videos, LANs, and other wideband transmissions is a necessity for overall economy. All communications equipment that is not co-located with the operator will be remotely controlled from his site. [Ref. 8: p. 13]

The advantages of this integrated communication approach are numerous, but perhaps the greatest is the unimpeded flow of information. Secondly, by bringing all information to a central control point, it allows the operator to respond quickly and easily to any operational request. Also, it enables the interconnection of communication assets to efficiently support large operations and provide a wider range of services to customers.

C. GUIDING PRINCIPLES FOR COMMUNICATIONS

Communications are the life blood and driving force for all operations; therefore, it is imperative that organizations design their communications capabilities to support their operations. The PMRF communications branch is charged with the management of optical, infrared, radio frequency, and acoustic spectrums in support of the command's overall mission. The communications/information systems must be integrated to cover the entire land, sea, and air environments. The future, more-operational focus of PMRF will not significantly alter the requirements placed upon the present system.

The guiding principles for the PMRF communications' branch master plan are adapted from the Corporate Information Management (CIM) plan [Ref. 13:p. 3]. These principles are the following:

- the frequency spectrum will be managed through centralized control and decentralized execution
- simplication by elimination and integration is to be preferred to automation whether developing new or enhancing existing communication systems
- proposed and existing systems will be subject to cost-benefit analysis which includes bench-marking against the best public and private sector performance

- new systems will be proven or validated before implementation

- communication systems performing the same function must be common unless specific analysis determines they should be unique

- the Communications Branch Head will be held accountable for all benefits and all directly controllable costs of developing and operating the communications systems

- communication systems will be developed and enhanced according to a DOD-wide method, and accomplished in a time-frame in order to minimize the cost of development and achieve early realization of benefits

- communication systems will be developed and enhanced in the context of process models that document business methods

- the communications infrastructure will be transparent to the information systems that rely upon it

- common definitions and standards for data will be used from the DOD information Resource Dictionary System (IRDS)

- communication services will be acquired through competitive bidding considering internal and external sources

- data will be entered only once

- access to information will be facilitated, and/or controlled and limited as required also information will be safeguarded against unintentional or unauthorized alteration, destruction or disclosure

- the presentation between the user and communications systems shall be friendly and consistent

The PMRF mission will be the deciding factor for all decisions pertaining to the purchase or installation of communication and information systems. The objective is to provide effective and successful communication services that are tailored to the range users needs.

D. IMPLEMENTATION ISSUES

As in the past, efforts to improve segments of the system could be continued. However, this would only add to the present problem and restrict operating the range at its most effective level. Several courses of action may be pursued in conducting the improvement and centralization of communication assets; however, the following actions must be taken.

1. Conversion to all-digital switch

Basic to whatever is done is the replacement of the analog switching system. The advantages of this are:

- it will greatly increase the reliability of the switching operation
- it reduces the manning required to support range communications by reducing maintenance man-hours
- it provides range operators greater flexibility in conducting range operations
- it increases the capability of the switch to conference, and to provide dial-up capability which expands the control of range operators

In addition to this action, the DENRO digital switch that was purchased in 1990 must be expanded to its specified line capacity limits. The present configuration severely limits the capability of the switch and does not allow for the transmission of wideband signals, e.g., T-1 or greater. With the expansion to an all-digital switch, the purchase of smart multiplexers will be necessary in order to provide the required digital bandwidth on demand. [Ref. 8:p. 21]

Conversion to an all digital format will also allow for the use of the Integrated Services Digital Network (ISDN) technology. ISDN provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services, to which the user has access by a limited set of standard multi-purpose user-network interfaces [Ref. 14: p. 174]. ISDN technology consists of digital transmission and switching architecture used to build an all digital telecommunications infrastructure. ISDN is designed to provide a flexible, efficient, and cost effective method for integrating and supporting voice, data, videotext, facsimiles, and video conferencing services.

Along with ISDN technology, the Broadband Integrated Services Digital Network (B-ISDN) is available to handle the increased demand for high bit rate services such as image and video services. It is not simply an extension of the narrowband ISDN; it is envisioned as an all purpose, wide area digital network designed to meet the growing demands for broadband services needed for support of high-speed data network interconnectivity [Ref. 14:p. 207]. The use of B-ISDN based upon the ISDN switch will provide the backbone for these multimedia systems. This B-ISDN will connect PMRF with the Defense Information System Network (DISN) through the synchronous optical network (SONET) asynchronous transfer mode (ATM) protocols.

2. Installation of Fiber Optics

There is a twofold requirement to install fiber optics. First, the aging and deteriorating cable now in the ground must be replaced. Secondly, fiber is necessary to accommodate the ever-increasing wideband data transmission requirements. The installation of single mode fiber optic cable to connect all fixed, land-based range facilities will meet both of these requirements. It will also provide a channel that is immune to electromagnetic interference. This fiber also will provide sufficient bandwidth to support SONET protocols.

As demands for more data to be sent between Barking Sands and Oahu increase, additional microwave systems or fiber optic cable becomes a necessity. Spectrum allocation will limit microwave expansion; therefore, fiber optics is the most efficient method. A joint venture with the Hawaiian Telephone Company (HAWTELCO) should be explored to lay cable between the two islands. This cable would eliminate the requirement for a satellite link between Kauai and Oahu, thereby saving thousands of dollars a month. This effort will extend the bandwidth, the potential number of circuits, and the quality of digital service from Kauai to Oahu in support of PMRF's mission. It would also allow for the connection of the Range Operations Center with the Commander-in-Chief Complex (CCC) at

Pearl Harbor. This link would provide for the real-time monitoring of data from all range operations.

3. Security Issues

Present regulations require that all range communications involving operation and evaluation data be considered classified, and therefore these communications must be protected. All network security requirements are implemented through multiple level security (MLS) software among the fixed facilities. The installation of an all digital switch will allow the conversion of raw radar video to a 1.544 million bits per second (mbps) digital stream for encryption so that communication security (COMSEC) and operation security (OPSEC) requirements are met. [Ref. 8:p. 12] Digital range conferencing switches have the capability to establish conferences under the control of a computer that is programmed to allow predetermined conferences to be easily called up. A properly installed system provides great flexibility, while providing the required security for operational information. Workstations that handle classified information are diskless and access a centralized database co-located with the ISDN switch. Any computer that has removable storage media will be continuously scanned by anti-virus software while connected to the network.

4. Local Area Networks

The required interconnection of all desktop computers and telephones at PMRF is accomplished through the ISDN interface. The Open Systems Interconnection (OSI) Reference Model provides the established framework for network interoperability. [Ref. 14:p. 377] This model has seven protocol layers with well defined interfaces, which allow interconnection of different systems at the lower levels.

5. Airborne Communication Platform

To reduce the need to extend fiber optic cable to Niihau to cover the requirement for additional radar and telemetry reception and video surveillance, an unmanned tethered aerostat at Kokee Park can be employed. The aerostat can be connected to the Range Operations Center via the secure B-ISDN multimedia network. The successful deployment of optical and RF communications systems on this platform will allow the closure of the facilities at Mauna Kapu, Mount Paniau and portions of the leased satellite circuits, while improving service and reducing costs. The C-12 aircraft that must be airborne during all operations will also no longer be required. The U.S. Coast Guard presently uses aerostats successfully for radar operations [Ref. 15:p. 9A]. Also, if the aerostat is tethered at Kokee Park the added elevation would effectively extend the range and allow for the commencement of range operations as ships leave the port at Pearl Harbor.

6. Goals

To achieve the vision of the Communications Branch, specific goals for the management of human resources, plant equipment, material and information must be achieved. Goals toward accomplishing this vision are:

- implement a training plan for CIM, unit costing and risk exposure analysis by the end of FY 93
- replace all analog switching systems with digital systems by the end of FY 94
- complete conversion to ISDN technology by the end of FY 95
- complete installation of the secure network by the end of FY 94
- install fiber optic cable between land-based facilities and begin multimode installation aboard installation by the end of FY 95
- develop a concept of operations for the aerostat by the end of FY 96
- begin installation of fiber optic cable between Kauai and Oahu by FY 96
- complete fiber optic installation to the Pearl Harbor CCC by the end of FY 99

7. Strategy

The "PMRF Communications Branch Status and Issues" document prepared in July 1991 accurately describes the technical implementation issues. Interviews with PMTC engineers revealed the need to include the underwater communications system in the plan [Ref. 16]. This system should be connected to the digital switch to allow interfaces with other aspects of the communications system. Strategies for the communications plan proposal are adapted from the CIM strategies [Ref. 14:p. 17]. They are the following:

- develop process models that document existing and new communications methods
- develop data models for communications methods that are consistent with the DOD methods
- develop and implement a set of cost effective, common communications systems based logically upon data and process models and based physically upon CIM technical standards
- manage expenditures for communications using the unit costing methodology
- institute a life-cycle management methodology
- establish measures for the value added to range operations through spectrum management, thereby allocating proper frequencies needed for different users who require the same type of services

VII. CONCLUSION

The current communications system at the PMRF was planned and implemented many years ago. As the number and needs of users increased, the system has been modified as necessary. However, much has happened since 1958 when the PMRF was established. The deployment of both digital transmission and switching has gone ahead full speed, driven to a large extent by economics in providing existing kinds of service. Part of the motivation for the development and implementation of digital systems came from improvements in quality of service resulting from the inherent advantage of digital systems over analog systems, which by their very nature do not accumulate the traditional impairments, such as distortion and noise, over distance.

The copper cable plant configuration at numerous locations of the PMRF is limited and costly to maintain. The limitations are becoming more evident as the need for ever greater bandwidth and new services increases. In addition, there is an increasing need to provide service at lower cost and with increased quality.

The time has come for the communication systems at the PMRF to be modernized. The obvious answer will be to increase the use of optical fiber. It is clear that such communication system transformation cannot occur overnight, however, the gradual process for change should begin immediately.

The major challenge in the deployment of efficient range utilization services is in having the service capabilities available when the service demand materializes. Presently at the PMRF this means struggling to accommodate range users' demand for services requiring particular circuits with enough detail and accuracy to permit range operations. If PMRF is to continue down the path of engineering and administering different facilities for each different type of service, the service provisioning process would undoubtedly soon become unmanageable. In fact, there are those at the PMRF who say that the process is already unmanageable because of the communication demands of sophisticated customers.

In the final analysis, technological communications improvements must serve the needs of end-users. This means that the PMRF must face the information productivity requirements of its customers. The drive toward a centralized communications system must integrate existing voice and data services in ways which are cost effective while defining a rich menu of new services and customer flexibility. This is no small task, but it is inevitable and should be accomplished. The pace of technology will drive it and economic benefits will depend on it.

This thesis concludes, therefore, not with an ending but with a beginning. The prospects of achieving effective manpower reductions and reasonable cost of maintenance and repairs for an integrated/centralized communications system at the PMRF would be immensely beneficial in the future years.

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